STAFF SUMMARY SHEET

	TO	ACTION	SIGNATURE (*Surname*), GRADE AND DATE		TO	ACTION	SIGNATURE (*Surname*), GRADE AND DATE
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SUMMARY

1. PURPOSE. To provide security and policy review on the document at Tab 1 prior to release to the public.

2. BACKGROUND.
Authors: Fiksel, Polyviou, Pettit, and Croxton

Title: "Embracing Change: From Risk to Resilience"

Circle one: Abstract Tech Report X Journal Article Speech Paper Presentation Poster

Thesis/Dissertation Book Other: ____________

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[] CRADA (Cooperative Research and Development Agreement) exists

[] Photo/ Video Opportunities [] STEM-outreach Related [] New Invention/ Discovery/ Patent

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Embracing Change: From Risk to Resilience

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About the Research

The authors have been researching the concept of enterprise resilience for over seven years. The purpose of this manuscript is to synthesize the managerial implications of the research and describe how the practice of enterprise resilience can help companies to manage their global supply chains in an increasingly turbulent business environment. The experience from which we draw includes research that we conducted from 2006-2010, as well as our ongoing efforts to fully understand the challenges and benefits of enterprise resilience. The initial resilience framework was the result of interviews conducted through in-depth focus group interviews with cross-functional managers of Limited Brands. The framework led to the development of the SCRAM assessment tool, which was validated with data from seven global manufacturing and service organizations. Mixed-method triangulation was used to identify specific linkages between the inherent vulnerability factors and controllable capability factors, enabling the tool to produce recommendations for capability improvement to overcome high-priority vulnerabilities. After this initial research phase, we worked extensively with Dow Chemical to help them establish a Supply Chain Resilience Assessment and Management process, which they have implemented in over 20 of their global business units. Additional insight has been gained through interviews and interactions with other organizations, including Zurich Financial, Johnson & Johnson, Owens Corning, Shell, Unilever and others.

Introduction

In an interconnected, volatile, global economy, supply chains are increasingly vulnerable, and disruptions can substantially affect shareholder value. Sudden disasters or even minor shipment delays can cause significant financial losses. Existing methods for coping with supply chain risks are based on the notion of stability as the "normal" state of affairs, and disruptive events such as explosions or floods represent unwanted deviations from the norm. Accordingly, enterprise risk management, business continuity management, and related business practices are intended to avoid supply chain disruptions and to recover normal operations as quickly as possible.

But what if the quest for stability is futile? In an increasingly turbulent business environment with complex global supply chains, the best strategy may be to embrace constant change as the new normal. Rather than sailing smoothly upon calm waters, companies are constantly testing their skills as they ride the waves of change, from exhilarating crests to frightening troughs. Those that are agile enough to navigate these challenges may succeed, while others that are unable to adapt may perish.

The established approaches to enterprise risk management are appropriate for a stable environment with predictable risks that occur intermittently and are relatively independent. However, in today's more complex and dynamic risk landscape, these approaches have fundamental shortcomings, and are unlikely to help in dealing with emerging risks that are unfamiliar or unpredictable. The most damaging disruptions are often a result of rare, "black swan" events whose consequences could not have been foreseen, let alone quantified through risk assessment.

Embracing change calls for a new paradigm built around the concept of ***resilience***, a trait typically found in living systems. We define enterprise resilience as the capacity "to survive, adapt, and grow in the face of turbulent change".[1] In the natural world, resilience is seen everywhere, from cells to organisms to entire ecosystems. Similarly, human communities are often resilient in the face of disasters, although we appear to be less effective at adapting to slower-moving changes such as rising sea levels.

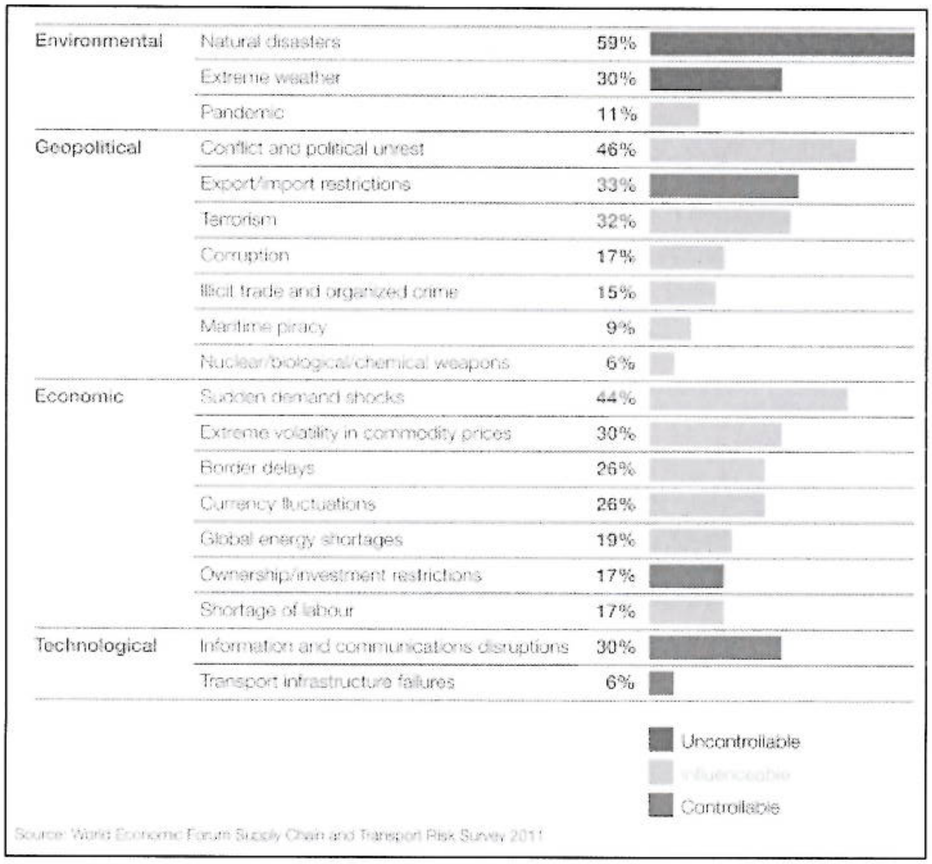
Business enterprises tend to lose resilience as they grow more complex—they become more rigid and vulnerable to surprises. Gary Hamel and Liisa Välikangas described the quest for resilience as seeking "zero trauma"[2], but few, if any, companies can make that claim today. However, some pioneering companies have identified resilience as a source of competitive advantage that complements their traditional risk management processes; indeed, "resilient dynamism" was the prevailing slogan at the 2013 Davos Summit. What this means in practical terms is transforming global supply chains, collaborating with stakeholders, and leveraging information technology to assure the continued viability of supply chains and markets, even in the face of catastrophic disruptions.

In a tightly connected world, resilience matters not only for individual companies but for the overall sustainability of the global economy. A company (or city, or nation) that fails to ride the waves of turbulence can scarcely be called sustainable. Therefore, in the coming decades, resilience will be an essential factor in coping with global challenges such as poverty, water scarcity, and climate change. Indeed, climate resilience has already emerged as a new risk factor for global supply chains.

Today's Supply Chain Risk Landscape

Contemporary supply chain managers face a variety of global forces that increase the potential for unforeseen disruptions. These forces range from increasing turbulence and complexity in the business environment to increasing economic, environmental, and social pressures. A recent report published by the World Economic Forum surveys the current landscape of global supply chain disruptions.[3] Respondents to the forum's survey ranked natural disasters, sudden demand shocks, extreme weather conditions, information and communication disruptions, and political unrest as the most important risks that can affect supply chains (see Figure 1). This indicates that some of the most important threats to supply chains today are neither preventable nor under the direct control of management.

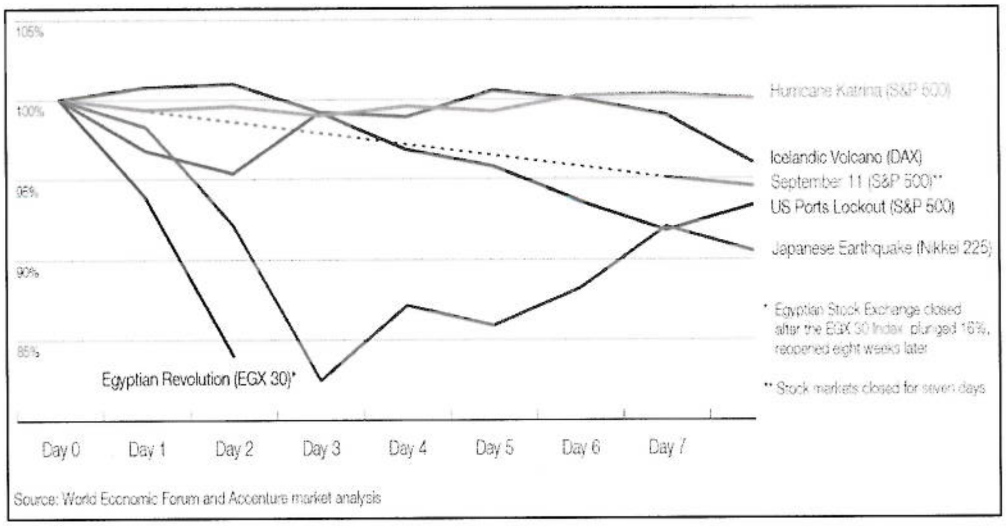
Figure 1. Relative importance of supply chain disruption triggers[3]



Source: World Economic Forum Supply Chain and Transport Risk Survey 2011

While the indirect consequences of disruptions are often difficult to quantify, changes in stock price can be an indicator of these effects. The same report from the World Economic Forum analyzed how stock markets responded in the aftermath of several major global disruptions (see Figure 2). Hurricane Katrina caused only a modest decline in the S&P 500, but other events caused steep drops in value. Previous research has shown that announcements of supply chain problems are correlated with abnormal decreases in shareholder value of about 10%.[4]

Figure 2. Stock market responses to global events[3]



Turbulence ahead

In a simpler time, it was possible for companies to retain tight control over their supply chain operations and to buffer themselves against external disturbances. Today, the business environment is dominated by turbulence, defined as "frequent changes in external factors beyond an organization's control".[5] Examples of turbulence include natural disasters, demand variability, geopolitical disruptions, and currency fluctuations.

Increasing intensity and frequency of **natural disasters** is perhaps the most visible factor. For example, in the fall of 2012, Superstorm Sandy struck the eastern part of the US and shut down port terminals, wrecked transportation infrastructure, submerged warehouses, and hindered the operations of many companies. Seaports located in the northeastern U.S. were closed to containerized traffic, while many freight carriers, including CSX, Norfolk Southern, and YRC either suspended their services or warned customers to expect delays.[6] To supply its delivery trucks, FedEx rented fuel tankers since commercial gas stations ran dry.[7]

While enterprises tend to focus on the supply-side of their supply chains when scanning for potential risk factors, they also need to pay attention to the customer-side. Increasing **volatility in demand** is an important factor that can affect a firm's operations and ultimately its revenue. For example, in March 2013 Cardinal Health announced that its pharmaceutical distribution contract with Walgreens would not be renewed after August 2013, since Walgreens decided to switch to another pharmaceutical distributor. Walgreens was one of Cardinal Health's largest customers, accounting for about 21% of revenue for 2012, and Cardinal Health's share price fell by 8.2%% immediately after the announcement.[8]

As a consequence of increasing turbulence, supply chain practices that work well in a stable business environment may no longer be suitable, and may reduce competitiveness. In particular, Just-In-Time (JIT) production and lean management seek to reduce inventories, minimize waste and process variability, and tightly control information exchange. This is often achieved by developing close relationships with a small number of suppliers. However, in a turbulent environment, these practices make supply chains vulnerable to disruptions due to the lack of buffer capacity. For example, after the earthquake and tsunami in Japan in March 2011, many companies that followed the lean inventory model were left exposed. Boeing 787 production was delayed, since Mitsubishi Heavy Industries, based in Japan, was the only supplier able to build the aircraft's wing. Similarly, General Motors closed its Chevrolet Colorado and GMC Canyon plant in Shreveport, LA, because it lacked components that were supplied from Japan.

Many manufacturing companies have sought to balance their "lean" approach with "agile" practices.[9] Some argue that supply chains should develop structural flexibility, defined as "the ability to adapt to fundamental changes in the business environment".[10] An example of a structurally flexible organization is Zara, which has developed a rapid-fire supply chain that is extremely responsive to the ever-changing fashion environment and to customers' preferences. To achieve this type of resilience, it may be necessary to sacrifice some efficiency.

Dynamics of globalization

Due to globalization of trade, supply chains have become longer and more complex, thus increasing the likelihood of disruptions. Moreover, anticipating disruptions in advance and managing them when they do occur becomes extremely challenging. Complex global supply networks are characterized by **limited visibility**, so that potential risks are hidden and their potential cascading effects may not be understood. This situation often results in "black swan" events that can be explained only after the fact. Nassim N. Taleb warns that "our world is dominated by the extreme, the unknown, and the very improbable ... while we spend our time engaged in small talk, focusing on the known and the repeated".[11]

Globalization was initially driven by companies locating their plants in countries with lower labor costs, such as China and India. However, disruptions such as the 2010 volcanic eruption in Iceland and the 2011 tsunami in Japan revealed the vulnerabilities of extended supply chains. For example, a report by the U.S. Federal Reserve notes that 41% of manufacturers surveyed by the Minneapolis Fed indicated that the 2011 tsunami in Japan had affected them negatively[12]. As a result, many manufacturers have reevaluated their sourcing options and are considering **reshoring** (also known as backshoring or onshoring), i.e., shifting operations back to their home markets. Table 1 lists examples of companies that plan to or already have reshored significant portions of their manufacturing operations. While these companies perceive multiple advantages to reshoring, including improved supply chain responsiveness and domestic job creation, reducing their exposure to risk has been an important driver.

Table 1. Examples of reshoring initiatives[13]

Company	Operations
Caterpillar	Shifted some production from Japan to a manufacturing site near Athens, GA to build small tractors and excavators.
Chesapeake Bay Candle	Shifted the production of its candles and home-fragrance products from China and Vietnam to Maryland.
General Electric	Moved the manufacturing of washing machines, fridges, and heaters from China to Louisville, KY.
Google	Built production capacity for its Nexus Q in San Jose, CA.
NCR	Opened plant in Columbus, GA where it builds ATMs and self-service checkout systems, moving operations from China, Hungary and Brazil

Corporate responsibility

A variety of forces have led companies to adopt "sustainable" business practices, often described as corporate **environmental and social responsibility**. These forces range from governmental regulations and stakeholder pressures to a desire for differentiation and innovative leadership. In a 2013 survey of over 1,000 chief executive officers, about half stated that sustainability will be 'very important' to the future success of their business, but 67% acknowledge that the business community is not doing enough to meet sustainability challenges such as poverty, climate change, water scarcity, ecosystem degradation, and mineral depletion.[14]

There is increasing public awareness and concern about **safe and ethical practices** in consumer product supply chains. For example, in November 2012, it was revealed that IKEA had tolerated the use of forced prison labor during the Cold War by its suppliers in communist East Germany. In August 2011, Zara was accused of accepting dire worker conditions and use of slave labor by its suppliers in Brazil. There have been numerous instances of mass casualties due to fires in offshore textile factories. Some industries, such as electronics and apparel, have formed worldwide coalitions that are demanding supplier compliance to strict codes of environmental and social responsibility.

Another global trend that increases the vulnerability of supply chains is **climate change**, which already appears to be causing rising sea levels and greater volatility in weather patterns. One consequence of climate change is severe droughts across the world, including the U.S., which create **water scarcity** and threaten crops and livestock. Many companies have recognized that extreme precipitation and flooding, as well as extreme droughts, can increase their supply chain risks.[15] For example, Johnson & Johnson is developing strategies to address water scarcity, since water and natural ingredients are critical components of its consumer products. Indeed, water stewardship is a concern for a wide spectrum of manufacturing sectors, as well as the energy sector. The oil and gas industries inject millions of gallons annually into aging oil fields to improve production, while electric power plants account for about half of annual water withdrawals in the U.S.[16]

Social media

The explosion of **social networking** and **digital media** has transformed the business environment, creating greater transparency but also potential for abuse. Due to these new forms of communication, information travels instantaneously, reaches more people, and can persist longer on the internet. Moreover, receivers of information often have no way of judging its accuracy or credibility, and the adverse effects of misinformation on brand image can be substantial. Viral dissemination of supply chain incidents or failures can damage company goodwill and license to operate; for example a fake BP public-relations Twitter account emerged after the BP oil spill in 2010 in the Gulf of Mexico, and currently has almost 140,000 followers[17]. Thus, social media pose extreme challenges to companies, including lack of visibility regarding information dissemination and lack of remedies to control the damage.

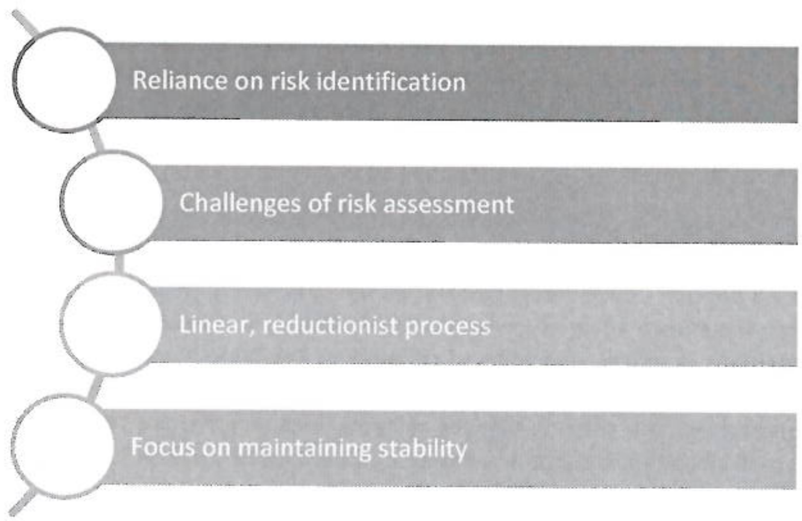
Limitations of Risk Management

Over the past several decades, most large private enterprises have adopted systematic approaches to manage the risks that they face, including both insurance coverage and active mitigation of supply chain risks. Attention to risk management was heightened by a number of highly visible events, such as the mass deaths in Bhopal, India caused by an inadvertent release of poisonous gas from a Union Carbide plant. Further motivation was provided by public entities, including the introduction of international ISO standards, SEC requirements management disclosure of "material" risks, and new regulations such as the German "Control and Transparency in Entities Law".[18]

A new, more integrated approach called **enterprise risk management** (ERM) emerged in the mid-1990s, and has been widely adopted by large firms.[19] ERM provides company executives with a comprehensive strategic view of the risks associated with different business activities, enabling more informed decisions on how to manage the risk portfolio. Another common risk management practice is **business continuity planning**, also known as business continuity management (BCM). This approach incorporates elements from disaster recovery planning and crisis management, including coordination of response to disruptions and maintenance of back-up capacity for operational systems.[20]

These established approaches have proved useful for protecting companies against predictable risks that are familiar and quantifiable, such as fires or power failures. However, they are not adequate for effectively dealing with the turbulence and complexity that characterize today's supply chain risk landscape. The limitations of risk management methods are described below (see Figure 4).

Figure 4. Limitations of established risk management methods



- **Reliance on risk identification.** The first step in any risk management process is risk identification. However, in a complex and turbulent global supply network, many of the risks that a company faces are unpredictable or unknowable before the fact. These "emergent" risks are often triggered by improbable events whose causes are not understood, and their potential cascading effects are difficult to understand *a priori*. Clearly it would be impractical for companies to identify and investigate all the potential risks that may be hidden in their global supply chains.

- **Challenges of risk assessment.** In order to assess the probability and magnitude of an identified risk, managers need a great deal of reliable statistical information. Risk assessments are limited by the quality and credibility of the assumptions upon which they are based, and faulty assumptions or data may lead to misallocation of resources. This is especially a challenge in the case of low-probability, high-consequence events for which there is little empirical knowledge; in fact, managers may underestimate the probabilities or magnitudes of risks that they have never experienced.[21]

- **Linear, reductionist process.** The traditional ERM process of risk identification, assessment, mitigation and monitoring is based on a reductionist view of the world. Each risk is identified and addressed independently, and hidden interactions are seldom recognized. This procedural approach can lull the organization into a false sense of complacency that is shattered when an unexpected event occurs, as is arguably the case with the BP oil spill in the Gulf of Mexico. The complex, dynamic nature of global supply chains requires constant vigilance to sense potential vulnerabilities, and exceptional agility and flexibility to respond to unexpected shocks.
- **Focus on maintaining stability.** Risk management is predicated on the assumption of stable operating conditions, so that risks represent potential deviations from this "normal" state. However, a more realistic view is to recognize that every disruption represents a learning opportunity, and may suggest a deliberate shift to a different state of operations, in other words, a new equilibrium. For example, a company that anticipates increased flooding in Southeast Asia might shift its supply base elsewhere. Organizations need to identify latent opportunities in the risk landscape, and be prepared to exploit such opportunities more rapidly than the competition.

In short, while ERM and BCM are valuable practices that should not be abandoned, organizations need new strategies and more innovative approaches to deal with supply chain complexity and unexpected disruptions. We believe that the resilience paradigm, which originated in the study of natural systems, can help to overcome most of the above limitations and enable companies to cope more effectively with the daunting challenges of the modern supply chain risk landscape.

The New Resilience Paradigm

Resilience has become a popular "buzzword", generally used to describe the ability of individuals or communities to bounce back from adversity. In the business world, resilience is often equated with traditional risk management practices, but years of research at The Ohio State University and other global institutions has produced a very different view of resilience. Scientists have observed that resilience is a fundamental characteristic of all living systems, including human systems. Resilience is part of our DNA, and resilient behaviors are often triggered instinctively. Likewise, companies can cultivate enterprise resilience to complement their risk management processes by developing inherent capabilities to embrace change and seize opportunities for transformative innovation.

Enterprise resilience refers to "the capacity of an enterprise to survive, adapt, and grow in the face of turbulent change".[1] Enterprises are actually living systems, and can emulate many of the behaviors seen in natural systems—tolerance for variability, continuous adaptation, and exploiting opportunities created by disruptive forces. A resilient system does not fail in the face of disturbances; instead, the system adapts to maintain its structure and function. Depending on the type of disturbance, adaptation can occur at different time scales, from instant response to gradual evolution.

In today's supply chain risk landscape, planning for specific risks must be augmented by building resilience so that the supply chain can overcome any type of disruption. Resilience goes beyond mitigating risk; it enables a firm to gain competitive advantage by learning how to deal more effectively with disruptions than its competitors[22], and potentially shifting to a new equilibrium. Indeed, it is possible for companies to design systems and business processes that are inherently more resilient and sustainable by increasing their diversity and adaptive capacity.[23] As illustrated in Figure 5, enterprises can use a combination of methods to cope with risk under different conditions, and inherent resilience is needed in situations where the business environment is volatile and many risks are unknown.

Figure 5. Appropriate strategies for different conditions

	Known risks	Unknown risks
Volatile system	Learning and adaptation	Inherent resilience
Stable system	Probabilistic risk management	Detection and response

One area that clearly falls in the upper right quadrant of Figure 5 is supply chain management, due to the dynamic complexity and unpredictability of global supply chains. The Ohio State University has collaborated with a number of companies to develop a comprehensive Supply Chain Resilience Assessment and Management (SCRAM) Framework[5]. This framework is based on explicit, although qualitative, characterization of vulnerabilities and capabilities (see Table 4). Dow Chemical has adopted the SCRAM framework and implemented it for over 20 of its global businesses, achieving significant business benefits.[24]

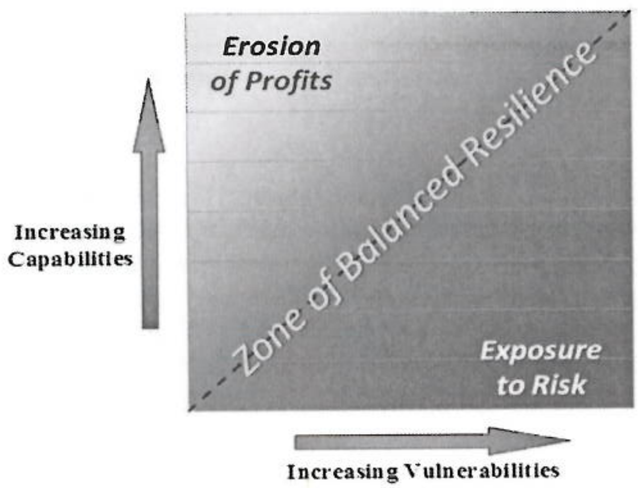
Table 4. Supply chain vulnerabilities and capabilities[5]

	Definition	Principal Factors in SCRAM Framework
Supply chain vulnerabilities	Factors that make an enterprise susceptible to disruptions	• Turbulence • Deliberate threats • External pressures • Resource limits • Sensitivity • Connectivity, • Supplier/customer disruptions

Supply chain capabilities	Attributes that enable an enterprise to anticipate and overcome disruptions	• Flexibility in sourcing
		• Flexibility in order fulfillment
		• Capacity
		• Efficiency
		• Visibility
		• Adaptability
		• Anticipation
		• Recovery
		• Dispersion
		    • Collaboration
		    • Market position
		    • Security
		    • Financial strength

The SCRAM approach provides a qualitative measure of supply chain resilience, which increases as capabilities increase and decreases as vulnerabilities increase. As shown in Figure 6, it is important for organizations to establish **balanced resilience** by developing the right portfolio of capabilities to fit the pattern of vulnerabilities that they face.[5] An organization with high vulnerabilities that does not have adequate capabilities will be overexposed to risks. Conversely, an organization that faces low vulnerabilities but invests heavily in capabilities may be eroding its profits unnecessarily.

Figure 6. Balanced resilience[5]



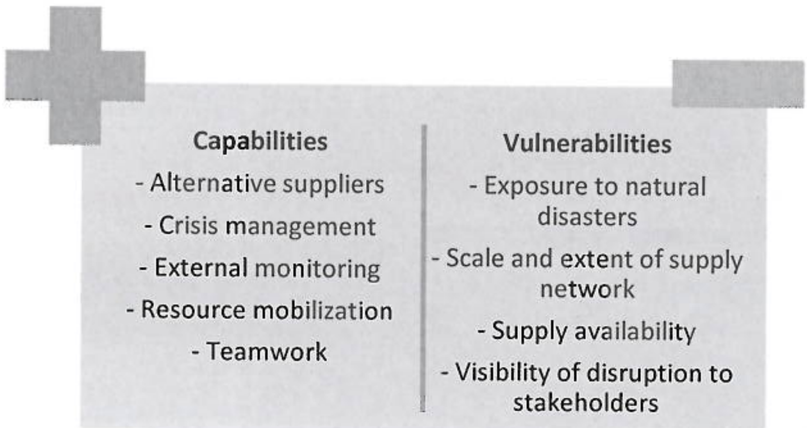
Resilience in the Real World

There are many examples of companies that have exhibited resilience and managed to overcome disruptions, as well as companies that were not resilient and suffered from disruptions. Here we provide three examples of how companies responded to the 2011 earthquake and tsunami in Japan—General Motors and Cisco demonstrated resilience, while Merck did not. In each case, we use the SCRAM framework to characterize the relevant vulnerabilities and capabilities.

General Motors (GM)

GM spends about 2% of its purchasing budget in Japan. Hence, the tsunami revealed a number of vulnerabilities, including exposure to natural disasters, supplier dependencies, and supply availability (see Figure 7). Yet, while GM's Japanese counterparts struggled for two months to resume production, GM was able to recover rapidly. Four days after the earthquake, GM mobilized its resources and initiated a disaster recovery action plan called 'Project J'. A team of employees gathered in three crisis rooms where they monitored the disaster and its consequences. They utilized supply chain mapping tools to identify components sourced by Japanese suppliers, categorize the status of the suppliers, and map the affected product lines. This exercise helped identify 118 problematic components, and the team took action by idling several plants to conserve supplies and seeking alternative suppliers for some of the parts. Further, GM employees visited the affected suppliers in Japan to assess the damages firsthand and help them to recover. Through Project J, GM was able to resolve 113 of the problematic components and managed to avoid any material impact on its earnings.

Figure 7. GM Capabilities and Vulnerabilities (based on SCRAM)



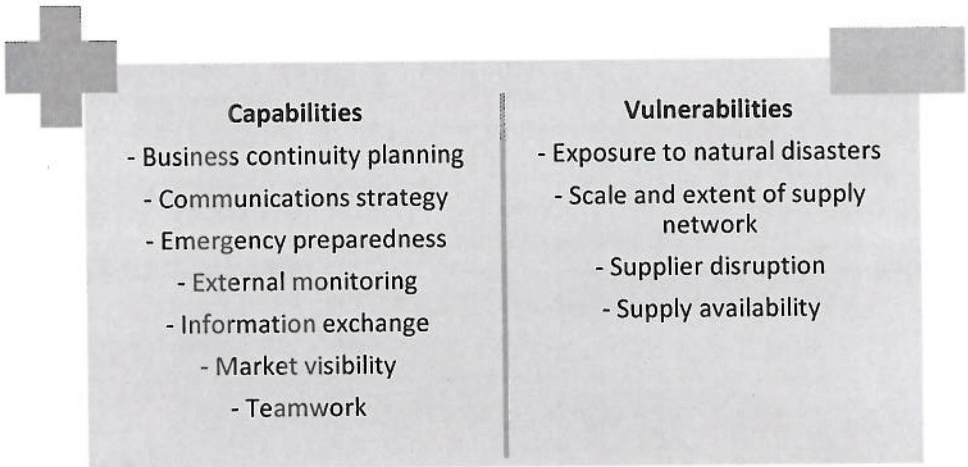
Cisco

Cisco's Supply Chain Incident Manager was aware of the Japan earthquake through alerts that the company receives from a third-party notification service. Within twelve hours, Cisco's Supply Chain Risk Management team, comprised of cross-functional managers, was activated and was able to identify all direct suppliers, their associated sites and components, as well as other critical nodes that were within the impacted area. In this way, the team established visibility into Cisco's risk exposure. Further, the manager was able to profile each supplier from various perspectives, such as expected time to recover, back-up generation capabilities, or whether the components were single sourced.

Contact with suppliers was established within a few days in order to assess the impact and the ability of the supplier to continue to supply components. A snapshot of each supplier's status was developed and refreshed on a daily basis, facilitating rapid and informed decision making. In addition, the company established a War Room within two days, through which the team handled the decision-making and communication of the team's strategy to the relevant stakeholders.

While Cisco's business continuity plans helped it respond to the disruption, it was the company's investments in resilience capabilities, such as improved information sharing, common information platforms, engagement with suppliers to anticipate outcomes, and constant communication with customers that helped the company emerge from the disaster unscathed (see Figure 8). Moreover, Cisco's partners praised the way the company handled this disaster, demonstrating increased customer satisfaction.

Figure 8. Cisco Capabilities and Vulnerabilities (based on SCRAM)

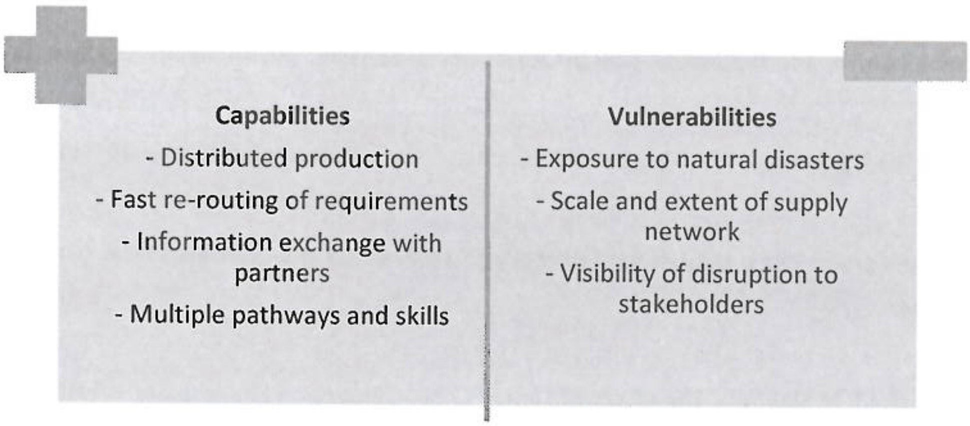


Merck KGaA

The disaster in Japan affected Merck KGaA adversely due to lack of resilience. The company produces 100% of the global supply of Xirallic, a pearl-luster pigment for automotive paint, in its factory in northeastern Japan. Following the tsunami, Merck closed its plant for two months and aimed to have another production line ready in Germany by the end of that year to continue with the production of the pigment. Meanwhile, Merck did not allow its customers to enter its plant to assess damages and help with restoring operations; instead, it kept them in the dark. The factory closure displeased Merck's customers, such as Toyota, Nissan Motor Co., Ford Motor Co., Chrysler, and Volkswagen AG, and subsequently several of them chose to develop the pigment in-house or search for other suppliers.

Merck could develop a set of capabilities that would help it deal with these vulnerabilities. To begin with, the concentration at one site of Merck's production capacity for Xirallic – a critical product for its customers – exposed the company to great vulnerability. Instead, the company could disperse production across several sites. Secondly, the organization could improve its flexibility in manufacturing by enabling a transfer of operations from Japan to its German plants, thus providing multiple production pathways. In addition, information exchange with partners is critical – especially during a disruption, when customers want to stay informed about the status of their products. Hence, Merck could strive to improve its collaboration and visibility capabilities. In addition, investing in anticipation capabilities such as scenario planning and emergency preparedness could help identify or prevent future disruptions (see Figure 10).

Figure 10. Merck Capabilities and Vulnerabilities (based on SCRAM)



The Road Ahead

Early adopters of resilience practices have already demonstrated how they can augment traditional risk management practices with new capabilities that help them to anticipate, prepare for, adapt, and recover from disruptions, and in some cases to treat disasters as an opportunity for gaining competitive advantage. Resilience is not a substitute for the established methods of enterprise risk management; rather it enables companies to embrace change in a turbulent and complex business environment by expanding their portfolio of capabilities.

In addition to the challenges of the global supply chain risk landscape, there are a variety of new drivers that are encouraging more attention to resilience. The concept of "resilient dynamism", a phrase introduced at the 2013 World Economic Forum, suggests that resilience needs to be a part of competitive strategy in a dynamic business environment. A number of multi-national companies, including Shell, IBM, Dow, and McKinsey have joined a CEO-led initiative to better understand the value of resilience and to develop resilience methods and tools. Meanwhile, President Obama issued an executive order to federal agencies to improve their resilience, and the National Academy published a report urging increased attention to urban resilience in the face of disasters. A particularly worrisome issue in the U.S. is prevention of catastrophic failures due to the hidden threats of aging infrastructure. Responding to these threats, Companies like General Electric and IBM see opportunities for new products, services, and markets.[25]

Resilience is a young field, and there is a great need for research both to understand the resilience of complex industrial systems and to develop innovative methods and technologies for improving enterprise resilience. This research will benefit from drawing upon multiple disciplines, from ecology to social sciences to systems engineering. From a management perspective, executives need to understand the cost-benefit trade-offs associated with building capabilities in order to judge the return on their resilience investment—this will require additional empirical research. Finally, there is a need to expand resilience thinking into other aspects of enterprise management, such as organizational resilience and behavior change. These changes will create organizations that can embrace change rather than resisting it, and are better fit for the challenging journey ahead.

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